HSE DISCUSSION DOCUMENT

The examination and testing of local exhaust ventilating plant

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INTRODUCTION

BACKGROUND

1 A number of Regulations for particular industries (Appendix 1 of the attached draft guidance) impose duties upon occupiers of factories to provide and maintain exhaust ventilating equipment to control airborne contaminants. Periodic examination of such equipment by a competent person is usually required, together with a report and record of the results of the examination.

2 Characteristically occupiers of factories have contracted to have such examinations carried out by independent agencies such as insurance companies and independent consultants.

3 Over the past 20 years or so there have been developments which now make it desirable for the methodology of such examinations to be reconsidered.

4 First, there have been improvements in the techniques of occupational hygiene which permit more accurate comparisons to be made between actual conditions of contamination of working environments and desirable limits to contamination. These techniques have also been much more extensively used. These changes have shown that in some cases examinations of ventilation plant have not revealed existing defects.

5 Second, extensions in medical knowledge have tended to suggest both that the medical effects of exposure to contaminants are more serious than was at one time thought and that smaller quantities of contaminant may be medically significant.

PRESENT POSITION

6 Since 1982 there have been discussions between the Health and Safety Executive (HSE) engineering inspecting agencies and others with the intention of specifying desirable technical features of statutory examinations of ventilating plant. As a result of these discussions three recommendations were made.

RECOMMENDATIONS

7 (a) Examinations should be a series of connected rather than isolated events. If it is established at a first examination that a plant is in effective working order and a full description of it is recorded then much of the work done at the first examination need not be repeated at subsequent examinations since relatively simple tests will reveal whether or not there has been a deterioration in performance. The system of examination should therefore provide for a "Part I" and a "Part II" examination.

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(i) The "Part I" examination would be both an evaluation of the plant and the occasion for making an adequate technical record of the plant and the process it was intended to control.

(ii) The "Part II" examination would be a simple thorough examination because it would be valid when carrying it out to depend upon data recorded at the Part I examination.

(b) A new register should be approved to replace the several at present in use and to accommodate a two part system of examination. Such a register has been compiled (Appendix 2 of the attached guidance) and pilot tested. Although the register has to be capable of recording a thorough examination of a large complex plant it can be used without any undue burden for recording examinations of simple plant.

(c) The HSE should publish guidance giving technical and other advice about a two part system. (A draft of such guidance is attached).

COST IMPLICATIONS

8 A Part I examination would introduce extra costs because new areas of expertise would need to be introduced, and the proposed recording of data itself would require additional resources. However subsequent Part II examinations could be simpler than present examinations competently carried out.

9 Unless there are significant changes in the plant or the process it controls, a Part I examination need only be repeated at long intervals. Therefore the average cost of all examinations need only rise very slightly, and this modest rise would be justified by an overall improvement in quality of examinations.

ACTION PROPOSED BY HSE

10 The HSE proposes to publish the attached guidance and to approve the draft register which forms Appendix 2 of the guidance for the purposes of the following Regulations:

(a) Blasting (Casting and Other Articles) Special Regulations 1949,

(b) Grinding of Cutlery and Edge Tools Regulations 1923,

(c) Grinding of Metals (Miscellaneous Industries) Regulations 1925/50,

(d) Non-Ferrous Metals (Melting and Founding) Regulations 1982 and

(e) Pottery (Health and Welfare) Special Regulations 1950.

11 Although the Asbestos Regulations 1969 are not included, the guidance refers to certain special procedures necessary for examining plant handling asbestos. The Health and Safety Commission recently published draft Regulations and a draft Approved Code of Practice (ACOP) for the Control of Asbestos at Work to replace the 1969 Regulations. The draft ACOP contains proposals for the thorough examination of exhaust ventilation systems. It would therefore be inappropriate for the HSE to approve the draft register in this document for asbestos at the moment.

IMPLEMENTATION OF CHANGE

12 It is proposed that the change to a two part system of examination be staged over a three year period. During this period both the new and existing registers will be approved and either the present or proposed system of examination will satisfy statutory requirements.

A GUIDE TO THE EXAMINATION AND TESTING OF LOCAL EXHAUST VENTILATION PLANT

(Draft of proposed guidance)

FOREWORD

INTRODUCTION

PERSONS APPOINTED TO CONDUCT EXAMINATIONS

PART I EXAMINATIONS AND TEST

PART II EXAMINATIONS AND TEST

EXAMINATION AND TESTING METHODS

TEST EQUIPMENT AND INSTRUMENTS

RECORDS

BIBLIOGRAPHY

APPENDICES

1. Legal requirements relating to LEV plant.
2. Register for recording Examination and Test results.
3. Guidance on the completion of the register.
4. HSE Area Offices.

FOREWORD

Local exhaust ventilation plant is used extensively throughout industry. The advice and guidance contained in this booklet should, therefore, find wide application.

Further information is contained in the Appendices and Bibliography. Advice may also be obtained from the Health and Safety Executive Area Offices (see Appendix 4) or from one of HSE's Enquiry Points at St Hugh's House, Trinity Road, Bootle, Merseyside L20 3QY, tel: 051 951 4381; Broad Lane, Sheffield S3 7HQ, tel: 0742 78141 extn 3113/4, or Baynards House, 1 Chepstow Place, London W2 4TF, tel: 01 229 3456 extn 6721/2.

INTRODUCTION

1 It has long been known that many processes of importance to man cause risks to health because of the properties of the materials involved, especially when airborne contaminants are released. In this country a number of statutory duties have been placed on those who employ people to work at such processes or whose undertakings cause risks to other people. Medical research raises new doubts about previously unsuspected substances and as new materials are also frequently introduced, it is likely that control measures will be more extensively applied in the future.

2 The use of some substances has been prohibited. Legal duties in respect of other substances vary in kind and extent and it is possible to meet these obligations in a variety of ways. These are set out below, and usually a combination needs to be implemented since it is often insufficient or imprudent to rely upon just one.

(a) Substitution by less hazardous materials
(b) reduction of emission at process
(c) adoption of good systems of work
(d) interception of emission from process
(e) reduction of concentrations of airborne contaminants
(f) restriction of exposure
(g) good general hygiene
(h) personal protection.

It is important to emphasise that this guidance is concerned with just one of the control techniques mentioned above, namely method (d). It sets out the broad technical principles which should apply in the thorough examination of local exhaust ventilation plant.

3 There are explicit legal obligations upon employers who carry out designated processes producing dusts or fumes to provide and maintain exhaust ventilation equipment for controlling the contaminants. The specific requirements are imposed by Regulations made under the Factories Act 1961 (see Appendix 1). In general they demand the provision of effective and suitable local exhaust ventilation (LEV). Periodic examination of such equipment by a competent person is usually required, together with a report and record of the results of the examination, and the rectification by the user of defects discovered during examination.

4 This guidance is equally applicable to any other circumstances where maintaining the efficiency of ventilation plant requires routine examination and testing, for example, in order to comply with the duties under Section 2 and Section 3 of the Health and Safety at Work etc Act 1974 (HSW Act).

5 LEV equipment is designed to control, by mechanical means, the emission of contaminants into the working environment. Normally this is done by intercepting the contaminant close to its point of emission in a stream of air and removing it to a place where it can be safely collected or diluted. The physical arrangements under which LEV equipment will work effectively are limited and comparatively minor alterations in performance or disposition can render it ineffective. It follows that LEV should be properly designed, constructed and set up. Unfortunately a great deal of LEV already installed does not meet these fundamental conditions.

6 This guidance is concerned with periodic examination and evaluation of LEV systems. However, this may be of little use if the system was badly set up in the first place.

7 The evaluation of the performance of LEV systems requires regular examinations. Every examination must be sufficiently thorough to reveal whether or not the system is continuing to fulfil its intended function. However, not all such examinations need to be equally extensive. The initial examination of the plant will usually require detailed measurements and tests to be made which, once completed, will not necessarily have to be repeated at subsequent examinations provided they are accurately recorded and that changes to the plant have not occurred. However, it should be pointed out at this stage that the degree to which it is proper to rely on recorded data will vary from case to case. In some instances (eg with carcinogenic substances such as asbestos) it will be necessary to repeat a large proportion of the test procedure at each thorough examination.

8 In this guidance an initial thorough examination including the recording of all relevant data will be referred to as a "Part I Examination" and subsequent thorough examinations as "Part II Examinations".

9 The results of each examination must be clearly and comprehensively recorded. Where there is a specific legal requirement for the results of an examination to be kept, the particulars set out in the register at Appendix 2 have been approved for this purpose. This register is also recommended for use in the examination of equipment where a statutory duty under a specific Regulation to examine it does not exist.

10 While the register has to be capable of accommodating reports of examinations of large and complex plants, not all of it will be applicable to simple plants.

PERSONS APPOINTED TO CONDUCT EXAMINATIONS

APPOINTMENT

11 The "competent person" appointed to carry out the examination and testing described in this guide should be capable, (if necessary with other expert assistance) of making a competent assessment of the efficiency and condition of the ventilation system, and its suitability in relation to the work being carried out.

12 There is no statutory definition of "competent person" in relation to the examination and testing of LEV equipment but the Courts have considered the meaning of the term on a number of occasions in similar contexts. It is suggested that until the Courts give the matter further attention a "competent person" may be regarded in general as

> "one who has sufficient practical and theoretical knowledge, as well as actual experience of the types of machinery or plant which are the subjects of the examinations, as will enable him to detect defects or weaknesses which it is the purpose of the examinations to discover and to assess their importance in relation to the strength and functions of the particular machinery or plant".

13 In the particular case of the examination and testing of local exhaust ventilation plant, which is installed exclusively for reasons of health and safety, it is clear that defects and weaknesses must include both mechanical aspects and failures of the system to achieve its purpose. As a result, the competent person should meet the criteria below:

(a) He should have received adequate training in inspection methods and techniques and in the correct use of the various instruments.

(b) He should have received sufficient training in, and practical engineering experience of, exhaust ventilation systems.

(c) He should have sufficient experience in inspecting and testing LEV systems to enable him to interpret his observations and the results, and to understand their significance in relation to the performance of the system.

(d) He should be familiar with the risks to health which are presented by the process and know the levels of control which must be achieved.

(e) He should be familiar with the particular work processes and activities which produce the airborne contaminants to be controlled by the LEV system and, should be able to examine the system against this wider background.

(f) He should, if he is unable to carry out all parts of an examination personally, be a proper judge of the extent to which he needs the assistance of other specialists.

PERSONAL PROTECTION

14 Different kinds of dangers may arise for people carrying out examinations and tests and a safe system of work should be devised to ensure the work can be carried out safely and without risks to health. For example, personal protective equipment and clothing should be provided. Suitable and, where necessary, approved respiratory protective equipment (RPE) should be provided and worn (eg during the internal inspection of flues, ductwork and filter units).

PART I EXAMINATION AND TEST

15 The purpose of this examination is twofold: first, to provide an accurate assessment of the level of control exercised over the contaminant by the LEV system, and second, when effective control has been achieved, to record in detail the performance and design specification of the system. It is likely that any accurate assessment of the level of control will involve sampling of airborne contaminants.

16 For examinations carried out under those Regulations set down in Appendix 1, the particulars in the register (Appendix 2) must be recorded. In all other circumstances the information collected from the Part I examination must be recorded in a suitable form (paragraphs 92-96 refer), and the use of the register for this purpose is strongly recommended.

17 A Part I examination and test should be made in the following circumstances:

(a) New Plant

Soon after, or simultaneously with, the commissioning of the plant. It is recommended that the plant be "run-in" for a short period before the examination and tests are carried out, to ensure that the results obtained are valid to use as a basis for long-term comparisons.

(b) Existing Plant

(i) Where no previous Part I examination has been carried out. In these circumstances initial tests should be carried out to determine the system's control over the contaminant. Only if this control is assessed as being satisfactory should the additional work of recording the detailed performance and condition of the plant be undertaken.

If the control is not satisfactory a Part II report should be issued describing the defects. Once the defects have been rectified a further Part I examination should then be attempted.

(ii) Where a modification has been carried out on the plant which significantly alters its performance or specification.

(iii) Where there has been a significant change in the process since the previous Part I examination.

18 A Part I examination should include at least the following elements:

(a) a full, detailed description of the plant and its ancillary equipment together with a schematic arrangement,

(b) an assessment of the level of control of the contaminant. Due account should be taken of any current occupational exposure limit such as the 'control limit' or if this does not exist the 'recommended limit'; Health and Safety Executive (HSE) Guidance Note EH 40 (obtainable from HMSO) lists the occupational exposure limits currently applicable in the UK, and

(c) a record should be made detailing the standards of performance of the various elements of the system when the plant as a whole is achieving satisfactory control over the contaminant.

19 Guidance about the details which should be recorded is contained in the explanatory notes on the completion of the register; this forms Appendix 3. The notes indicate the steps which the Competent Person must take in assessing LEV systems.

PART II EXAMINATION AND TEST

20 The purpose of this examination is to provide a periodical assessment of the dynamic performance and condition of the ventilation system. It should be carried out at regular intervals, which in the case of processes attracting specific Regulations (see Appendix 1), will be stated within the Regulations. A Part II test and examination will, when taken together with an earlier but still valid Part I examination, provide sufficient information to satisfy the requirements of the Regulations.

21 As with a Part I examination, the particulars in the register which forms Appendix 2 must be recorded where the Regulations apply. This register is also recommended for recording the results in all other cases.

22 A Part II examination and test should include at least the elements listed below.

(a) An examination of the whole system for external signs of damage, wear, corrosion and malfunction.

(b) A qualitative assessment of the level of control and degree of containment of the contaminant by the use of a dust lamp (an essential test for all plant handling asbestos based materials), or other suitable method. In some circumstances it may be desirable to carry out ai monitoring. The results should be compared with both th data obtained at the Part I examination and the curren occupational exposure limit.

(c) Measurement of static pressures, air velocities etc under operating conditions. The results should be compared with those recorded at the Part I examination. Any performance deterioration should be investigated thoroughly.

(d) Any air cleaning equipment, eg cyclones, fabric filters or electrostatic precipitators should be examined for signs of damage, wear and overloading and, where appropriate, the pressure drop across the unit should be measured. Cleaning systems handling toxic gases and vapours should be tested with due account being taken of any advice given by the equipment manufacturer.

(e) In the case of captor systems the distance between the hood and the source of contaminant should be closely checked to ensure it is within the design specification.

(f) All automatic monitoring devices should be appropriately tested and examined.

(g) A record should be made of any modifications to the plant or changes in process since the Part I examination was carried out. If any significant changes have occurred a further Part I examination will be necessary.

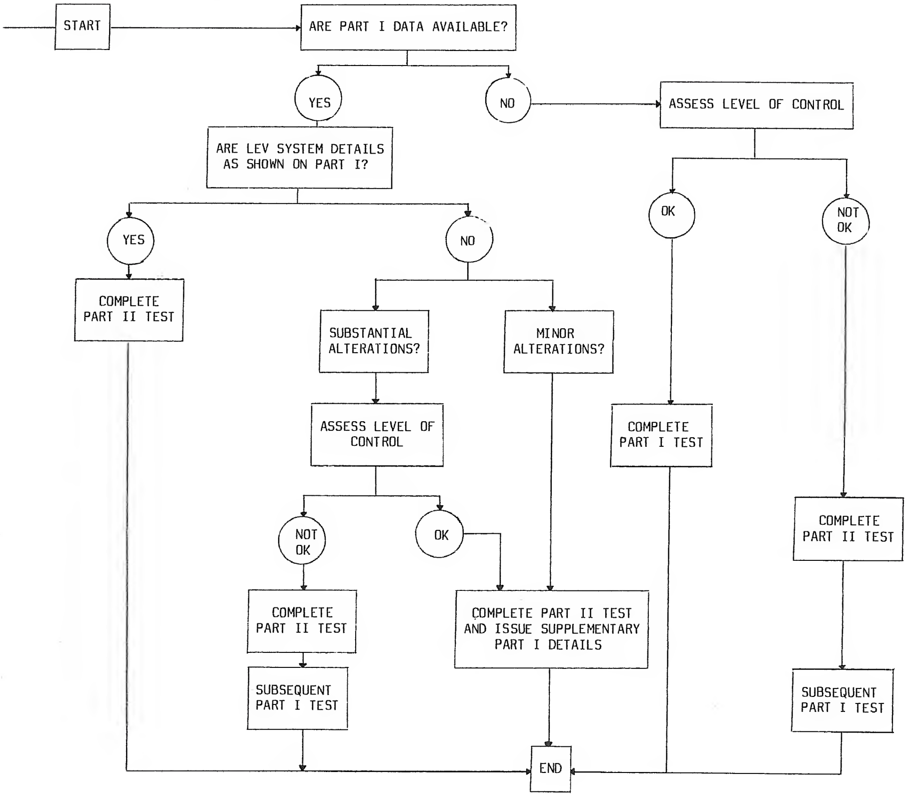
23 On completion of this work the details of the tests and examination should be recorded in an appropriate form (see Appendix 2). A report should then be prepared by the person who undertook the examination, detailing any repairs or modifications which need to be made, either immediately or within a specified time, by the user of the ventilation plant.

24 If the register which forms Appendix 2 has been used, the repairs, once they have been completed, should be recorded by the user in Part III of this register.

25 The flow chart opposite will assist the user or examiner to determine whether a Part I or Part II examination is required. Again, the notes on the completion of the register at Appendix 3 show the details which are required from the Part II examination.

EXAMINATION AND TEST OF LOCAL EXHAUST VENTILATION EQUIPMENT

ACTION CHART



EXAMINATION AND TESTING - METHODS AND PROCEDURES

26 The information contained in this section is intended only as a guide to the various methods and procedures which could be used. Statutory requirements, Approved Codes of Practice, the nature of the contaminant and special features in the design of the particular LEV system may all necessitate additional examinations or tests.

27 Whoever carries out the examinations and tests must be competent to do so. In particular, if the procedure requires the use of instruments, he should have sufficient practical and theoretical knowledge, and actual experience of using them to enable him to perform this task effectively.

QUALITATIVE ASSESSMENTS

Unaided Visual Examination

28 The whole LEV system and its ancillary equipment should be visually examined for damage, leaks and excessive corrosion. This should include inspection of the position and condition of flow dampers, fire dampers, explosion relief panels etc and the external condition of all mains services to the system eg water, gas, electricity supplies.

Using Illuminating Devices

29 Many of the contaminants which are controlled by an LEV system are invisible under normal lighting conditions. However, if dust is illuminated by means of a high intensity beam of light, dust particles within the respirable size range, ie less than 10 micrometres diameter, become visible.

Dust Lamp

30 The lamp does not indicate the quantity of dust present but enables a qualitative assessment of the observed dust cloud to be made. It may be used to observe, photograph or film the movement of a dust cloud.

NOTE: Where asbestos material is being handled by the LEV system the dust lamp must be used as an element of the Part I and Part II examinations.

A detailed description of the instrument is given at paragraphs 51-53.

31 The lamp should be used to examine the source and movement of the dust to check that the dust cloud is controlled by the LEV system. The instrument may also be used to check for leaks in ducting and air cleaning systems which handle dusts.

Smoke Generators

32 These are useful where the contaminant is not visible under any lighting conditions. It should be remembered, however, that smoke is a dispersal of very fine particulates and may behave differently from dust, especially when the dust has appreciable kinetic energy.

QUANTITATIVE ASSESSMENTS

Air Flow Measurements

Face Velocity

33 This term is defined as the velocity of the air passing through the inlet, measured in the plane of the inlet. The face velocity necessary to ensure effective retention or entrainment of the contaminant for any given system will be determined by several factors including: the design and siting of the extraction equipment, the nature of the contaminant, the aerodynamic features of the work opening and the nature of the work as it is carried out.

34 During face velocity measurements all other equipment and processes in the vicinity should be operated normally. The velocity should then be measured at a number of points. This is best done by dividing the face area under examination into smaller cells. The number and position of the points chosen should ensure that the velocity readings accurately represent the air flow pattern as it enters the system. The mean value of the velocity measurements should be calculated and recorded as the 'average face velocity'. Any point at which the velocity differs significantly from the mean value should be noted and the reasons investigated.

35 Face velocities are normally measured using one of the following types of instrument:

swinging vane anemometer
rotating vane anemometer
hot wire anemometer.

These instruments are described in more detail at paragraphs 67-78.

Capture Velocity

36 This term may be defined as the velocity of air at some point in front of the LEV hood or opening which must be achieved in order to capture the contaminant at the furthest point of evolution and cause it to flow into the system. The actual velocity required will depend on the nature of the contaminant and its kinetic energy, the design arrangement of the LEV hood and any extraneous air currents in the work area.

37 The equipment used for measuring the actual velocity at the capture point is similar to that for face velocity measurements. A note should be made of the distance between the point of evolution of the contaminant and entry to the LEV system. The system will not adequately capture the contaminant if this distance is greater than the design specification.

Air Flow Rate

38 The volume of air entering the system can be calculated from the equation:

$$Q = V \times A$$

Q = volumetric air flow rate
V = mean face velocity
A = area of face through which the air enters the LEV system.

Due account should be taken of any make-up air or air by-pass system which may be installed.

39 The volume of air entering the work opening should be sufficient to entrain all the contaminant and take it into the system.

40 If it is suspected that there are leaks in the system then further air flow rate measurements should be taken at various points along the ducting. For instance if the flow rate increases towards the fan then leaks are present.

Velocity in Ducts

41 Velocity measurements should be taken at various points along the ductwork, eg

(a) in the branch ductwork from the inlet,

(b) on each horizontal run, or

(c) immediately upstream and downstream of the fan and, if fitted, any air cleaning system.

Readings are taken across the diameter or width of the duct, the number and position of these readings being determined by the duct diameter or shape, and the characteristics of the instrument being used. The readings should be averaged to give a mean duct velocity.

42 Instruments which may be used for duct velocity measurements include:

pitot tube
swinging vane anemometer with duct probe
hot wire anemometer.

PRESSURE MEASUREMENTS

43 Air within an exhaust ventilation system moves from one point in the system to another as a result of the difference in pressure between these points (ie air tends to flow from an area of relatively high pressure to an area of lower pressure). Air moving within the system exerts a pressure in the direction of its flow, and this is known as 'Dynamic Pressure'. The force which is exerted normal to the walls of the duct is known as the 'Static Pressure'.

44 Air flowing through a system encounters frictional resistance and looses energy due to turbulance. The pressure relationships at points in a ventilation system may be expressed by the following equation:

$$P1 = (Ps + Pd)_1 - (Ps + Pd)_2$$

Where: Ps = Static Pressure
Pd = Dynamic Pressure
P1 = Losses in Pressure between positions 1 and 2.

Pressure measurements are important indicators of the energy losses in, and condition of, an LEV system.

Static Pressure

45 In assessing an LEV system, static pressure (Ps) measurements need to be taken at various points such as in the ductwork leading from the various hoods and inlets, at the fan inlet and outlet and across air cleaning units. Static pressure measurements taken either side of a filter unit provide the value of the resistance across the unit. With particulate filters this provides an indication, assuming there are no tears in the fabric or leaks around the seal, of the dust loading on the filter material. The measurement of static pressure is straightforward and can be taken using one of the following instruments:

'U' tube or inclined manometer
pitot tube
swinging vane anemometer fitted with a static pressure jet
aneroid type gauge.

These instruments are described in greater detail at paragraphs 56-73. Note should be taken of the relative limitations of each type of instrument.

46 Readings are normally taken, depending on the instrument used, by placing the probe through, or on, a small hole in the wall of the ducting. The position of this static pressure hole is not critical, but measurement of static pressure or dynamic pressure near bends or other points of turbulence should be avoided. Burrs on the inside of the duct may also cause turbulence and for this reason it is recommended that the static pressure test holes should be drilled rather than punched.

Dynamic Pressure

47 Readings are normally taken using a pitot tube which provides the dynamic pressure (Pd) from which the velocity of the airstream (V) can be obtained. See paragraphs 64 and 65.

48 Air does not flow at uniform velocity in the cross section of the duct. Readings should therefore be taken at several points across the diameter.

The pitot tube is described more fully at paragraphs 56 to 66.

AIR SAMPLING

49 Air sampling for the presence of contaminants in a workplace can be a valuable part of the examination and testing of LEV plant. It should be directed by a competent occupational hygienist who should also interpret the results.

50 As a part of the examination of LEV, air sampling is only appropriate if the concentration of the contaminant at the sampling position can be linked to the effectiveness of the exhaust plant. High levels of contamination may arise from sources other than those intended to be controlled by the equipment, eg materials being manipulated elsewhere in the workroom. It is not unknown for exhaust equipment to draw contaminants from other areas into the breathing zone of operators working at processes controlled by LEV. In such cases, although air sampling may be desirable it is not directly revealing about the effectiveness of the exhaust equipment.

51 To assess the level of control of contaminants by LEV systems, air sampling may be needed:

(a) at a Part I Examination unless a competent hygienist advises that this is unnecessary, and

(b) where the contaminant is a gas or vapour.

52 The sampling procedure and choice of equipment depend to a great extent on the exposure limits of the contaminants and on the techniques available for analysis. The procedure will usually involve personal and/or background sampling.

Occupational Exposure Limits

53 There are two limits: 'Control Limits' and 'Recommended Limits'. The former term is used to denote an occupational exposure limit which is contained in Regulations, Approved Codes of Practice, in European Community Directives or which have been adopted by the Health and Safety Commission (HSC). They are limits which have been judged after detailed consideration of the available scientific and medical evidence to be 'reasonably practicable' for the whole spectrum of work activities in Great Britain. These limits should not normally be exceeded.

54 The second category, 'Recommended Limits', are considered to represent good practice and realistic criteria for the control of exposure, plant design engineering controls and, if necessary, the selection and use of personal protective equipment.

55 Both types of limit for all substances are kept under constant review and may therefore change from time to time. Guidance Note EH 40 Occupational Exposure Limits obtainable from HM Stationery Office provides a list of the current limits, together with further explanation of their meaning.

TEST EQUIPMENT AND INSTRUMENTS

INTRODUCTION

56 It is the intention of this section to provide specific information on the function and use of some of the more common instruments and items of equipment which may be used during Part I and Part II examinations. The list is not exhaustive and alternative equipment may be available. Instruments must be used with care and it is imperative that the competent person carrying out the tests is aware of the limitations of each instrument. Furthermore some instruments may present additional hazards in use for example, a dust lamp may not be suitable for use in flammable atmospheres. All instruments and ancillary equipment should be serviced in accordance with the manufacturer's instructions. Major servicing and recalibration checks should be carried out annually, or more frequently if so directed by the manufacturer.

DUST LAMP

57 Dust in the respirable range (less than 10 micrometres diameter) can be seen and photographed if it is illuminated by a high intensity beam of light. The dust cloud should be observed by looking up the beam towards the source of illumination and, if possible, against a dark background(Fig 1).

Types of lamp commonly used:

58 (a) Mains Operated

The parabolic reflector unit which provides fixed focusing to give a parallel beam of light is fitted with a quartz iodine 12 volt lamp powered from a 240 volt single phase supply through a double wound transformer.

The transformer and supply cable should be sufficient in size and capacity for the duty. It is recommended that the cable from the transformer to the lamp be less than 3 metres long to prevent any loss of illumination.

Lightweight mains operated lamps designed for photographic work are available with output ratings up to 2000 watts. A plain glass safety screen must be fitted to the reflectors of these lamps and divergence of the beam can be reduced by the fitting of 'barn doors' on the reflectors.

(b) Battery Operated

These units are normally supplied in a case fitted with rechargeable, dry cell batteries capable of giving a continuous 12 volt output for approximately 60 minutes.

Small hand held photographic lamps "Hand Buchers" are widely used in TV and cine photography. These units operate from 12-30 volts and provide a continuous output of between 100 to 250 watts for a time period of 10 to 60 minutes, depending on the size of the battery pack.

59 The higher rated lamps can be used to great advantage in areas where the ambient light is high and they also have sufficient intensity to illuminate larger areas than the smaller lamps. A panning technique may be necessary with the lower-powered lamps or where large areas have to be observed as shown in the diagrammatic sketch below.

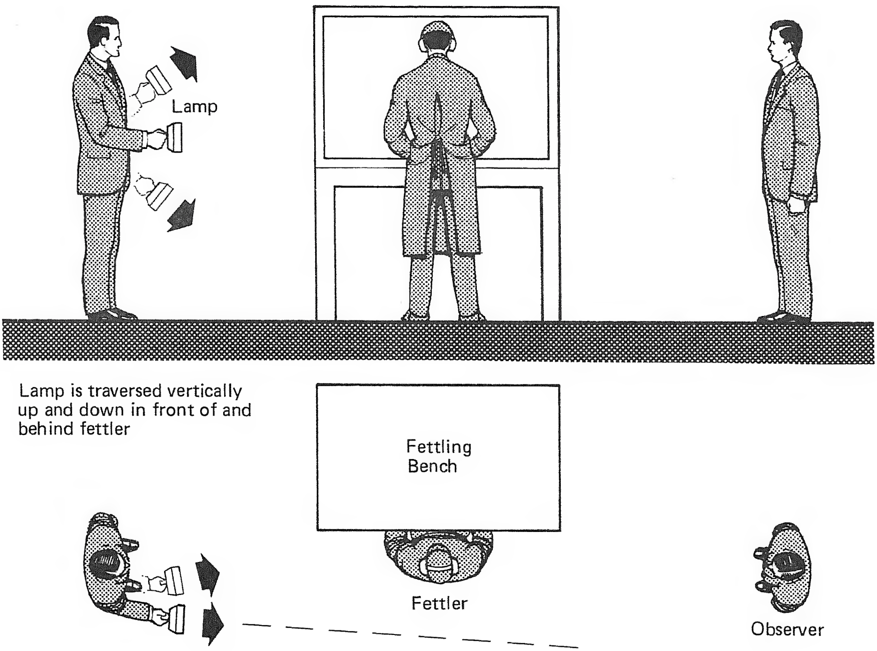

Lamp
Lamp is traversed vertically up and down in front of and behind fettler
Fettling Bench
Fettler
Observer

Fig 1 Use of dust lamp

AIR SAMPLING EQUIPMENT

60 Effective and reliable atmospheric sampling is dependent not only on the preparation and subsequent use of the instruments, but also on the techniques used in deciding the positioning and timing of the samples and the interpretation of the results.

61 Information about these matters is contained in a range of Guidance Notes and other literature published by the HSE. The HSE is willing to give advice on sampling and related matters and an initial approach should be made in the first instance to the local Area Office of the HSE.

AIR FLOW MEASUREMENT

Pitot Tube

62 The instrument (see Fig 2) consists essentially of 2 concentric tubes, the inner tube measures the total pressure in the system and the outer one, the static pressure. As the total pressure at any point in a system is given by the equation:

Total Pressure = Static Pressure + Dynamic Pressure;

this instrument can also be used to measure the dynamic pressure at that point.

63 Readings may be obtained by connecting the instrument, in one of 3 ways, to a manometer as shown in Fig 3. The use of this instrument is discussed more fully in British Standard BS 1042: Part 2: Section 2.1: 1983.

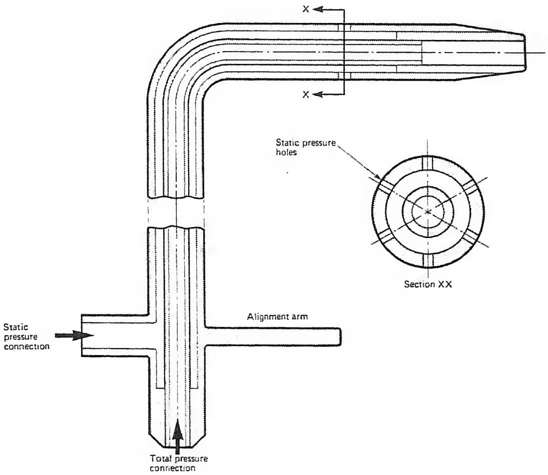


Fig 2 Pitot tube

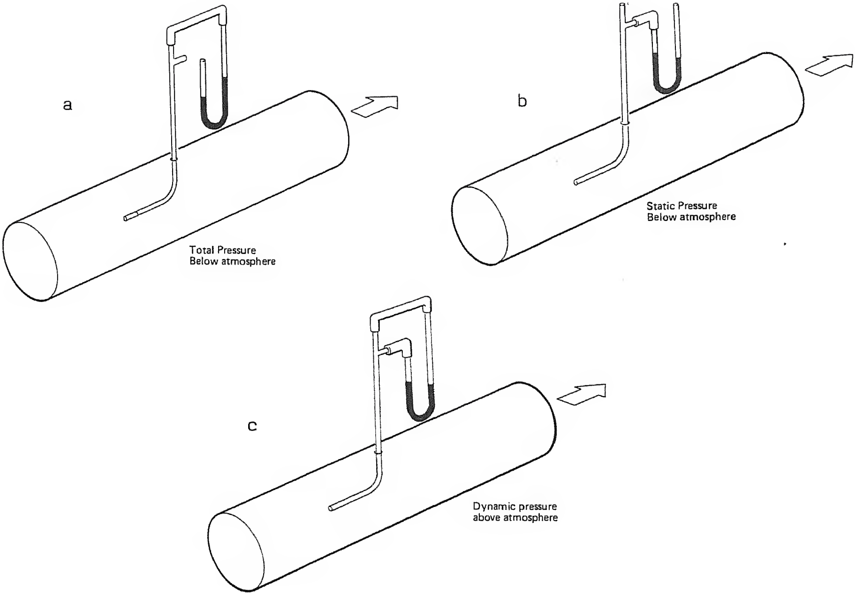


Fig 3 Total pressure = Static pressure & Dynamic pressure

64 The dynamic pressure (Pd), which is measured by connecting the device as shown in Fig 3(c), can be used to obtain the velocity of the airstream in a duct from the equation:

$$V = 4.43\sqrt{\frac{Pd}{\rho}}$$

Where V = air velocity in m/s
Pd = dynamic pressure in mmWG
ρ = air density in kg/m^3
(ρ = 1.293 kg/m^3 at 0°C)

65 For air at a temperature of 20°C and barometric pressure 1 bar the following equations may be used to obtain the velocity of the airstream:

$V = 1.29\sqrt{Pd}$ V in m/s, Pd in pascals
$V = 12.9\sqrt{Pd}$ V in m/s, Pd in millibars
$V = 4.04\sqrt{Pd}$ V in m/s, Pd in mmWG

For air at other temperatures and pressures the density of the air can be obtained from the equation:

$$P = \frac{1.293 \times 273 \times B}{(273 + t) \times 1013}$$

where; P is in kg/m^3
B = barometric pressure in millibars
t = airstream temperature in °C

66 For most LEV systems the barometric pressure can be taken to be 1013 millibars, but corrections for temperature may be necessary where there are significant departures from an airstream temperature of 20°C. For example, air at 20°C with a dynamic pressure of 20 mmWG has a velocity of 18.05 m/s but at 80°C and 20 mmWG the velocity is 19.81 m/s; an increase of 9.75%. Temperatures below 20°C are not frequently encountered and as the example above shows a correction may not be necessary with airstreams in a temperature range 20°C - 80°C.

67 If air contains moisture in significant quantities this may need to be taken into account using psychrometric charts.

68 A 'U-tube' manometer is shown in Fig 4, but for velocities in the lower measurement range of the instrument an inclined tube manometer should be used. The pitot tube cannot accurately measure velocities less than 3 m/s.

69 Air flowing through a confined system is subjected to resistances, or drag, at the duct boundary. The air velocity within a duct will not be uniform over the cross section. Several readings must therefore be taken by traversing the pitot tube on the cross section. British Standard BS 848: Part 1: 1980 shows the location of the traverse positions for measurements in ducts of various shapes.

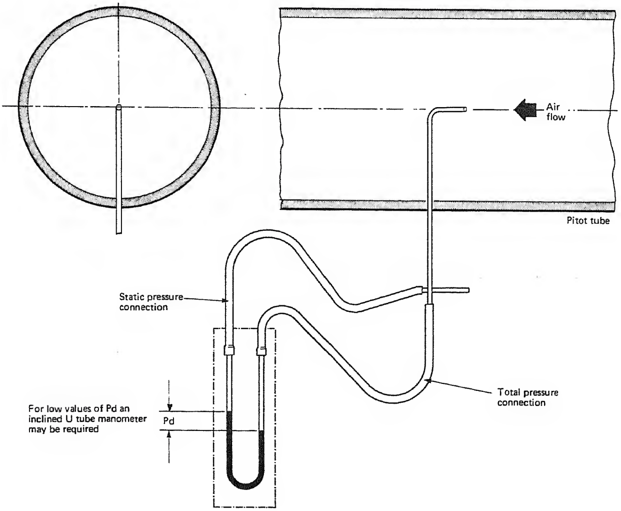

Air flow
Pitot tube
Static pressure connection
Total pressure connection
For low values of Pd an inclined U tube manometer may be required
Pd

Fig 4 U Tube manometer

70 Ductwork configurations are often complex. The following guidelines should assist in identifying the optimum position in the duct where readings may be taken:

(a) If the ductwork is convoluted, an attempt should be made to identify two straight lengths of duct, each not less than three duct diameters in length, in the same branch. If the readings taken in these two lengths do not agree to within 10%, then a further reading should be taken at another straight section. If there are divergences of more than 10% in all three readings, the results cannot be accepted as being accurate.

(b) The number of readings necessary on each traverse will vary depending on the size and shape of the duct. On circular ductwork of less than 250 mm diameter, then a single traverse as shown in Fig 5(a) would normally be acceptable. Near to the centre line two further readings should be taken by swivelling the pitot tube upwards and downwards.

On circular ductwork greater than 250 mm diameter two or more traverses may be necessary as shown in Fig 5(b).

With rectangular ductwork the approach shown in Fig 5(c) should be adopted. The number of readings should be as large as possible in the time available.

(c) The use of a single centre line reading for obtaining average duct velocity is, at best, a very rough approximation and should only be used in ductwork of small cross sectional area, and where the straight length of duct in which the readings are taken is at least 7.5 duct diameters from any bends, branches, restrictions etc which may produce turbulence.

In these situations the dynamic pressure (Pd) should be multiplied by 0.81 or, alternatively, the calculated velocity by 0.90 to obtain an approximation of the average velocity ie

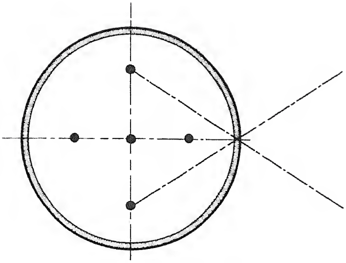
$$V = 4.04\sqrt{Pd \times 0.81}$$

Where; V is in m/s
Pd is in mmWG

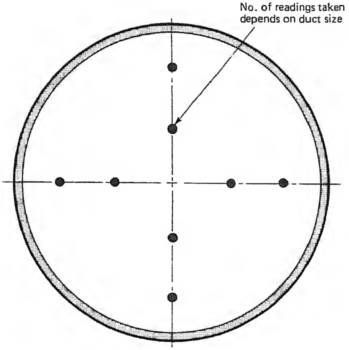
$$\text{or } V = 4.04\sqrt{Pd} \times 0.9 = 3.64\sqrt{Pd}$$

(d) Where a high degree of accuracy is required the procedure given in BS 848: Part 1: 1980, should be used.

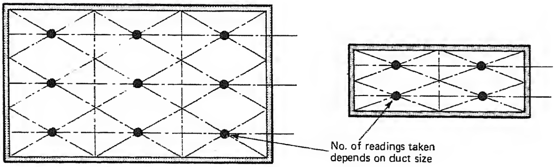
71 Pitot tubes should not be used to measure air velocities where the airstream carries a heavy dust load as the entrance holes to the instrument may become blocked with dust. They may be used in airstreams up to 400°C but the time of exposure in the airstream should be brief.



a) Circular Ducts up to 250mm dia.



b) Circular ducts over 250mm dia.



c) Rectangular ducts

Fig 5 Pitot measuring points - For approximating average velocity for routine test purposes. For accurate assessment consult BS 848 Part 1 1980

72 The instrument is not suitable for measuring airflow into inlets where the air is accelerating, or from discharges where the air is decelerating.

Swinging Vane Anemometer

73 This type of instrument is extensively used and consists of a box containing a hinged vane. The vane is mounted on low friction bearings so that movement of air through the box deflects the vane. This movement is reproduced on a pointer which moves across a scale.

74 The Velometer is one example of this type of instrument. As with all instruments, the detailed information and instructions issued with the Velometer should be studied carefully.

75 Some of the measurements which can be made using this instrument are listed below:

(a) Face Velocity

The meter should be used, in an upright position, to measure the velocity of the airstream as it enters the LEV system as shown in Fig 6. The inlet port must be held flush with the plane of the opening pointing upstream and the unit held clear of the observer. Readings should then be taken at a number of points of equal area across the opening and the results averaged to obtain a representative reading.

With no jet fitted the unit can measure velocities in the range 0-1 m/s (2-200 ft/min). Higher velocities can be read by screwing an orifice jet (prefixed LH) into the left hand or inlet port. In this manner velocities up to 10 m/s (2000 ft/min) can be measured.

(b) Duct Velocity

Various probes may be attached to the Velometer, one of which allows measurement of the air velocity in a duct.

When connected, via rubber tubing, to the appropriate orifice probes which are screwed into the inlet and outlet ports of the Velometer, duct velocities up to 30 m/s (6000 ft/min) may be measured. Traverses of the duct should be carried out in the manner described at paragraph 70, to obtain an average duct velocity. The instrument can also be obtained to read velocities of m/s.

76 The instrument may also be used to measure static pressure (Ps) in a system, and this is described more fully at paragraphs 85-87.

77 The Velometer should not be used in corrosive atmospheres. A filter is supplied for attaching to the inlet port which allows the instrument to be used in dust-laden airstreams. It should not be used in negative pressures exceeding 500 mmWG or in temperatures above 95°C. The instrument can be severely damaged by dropping it or by blowing compressed air through it.

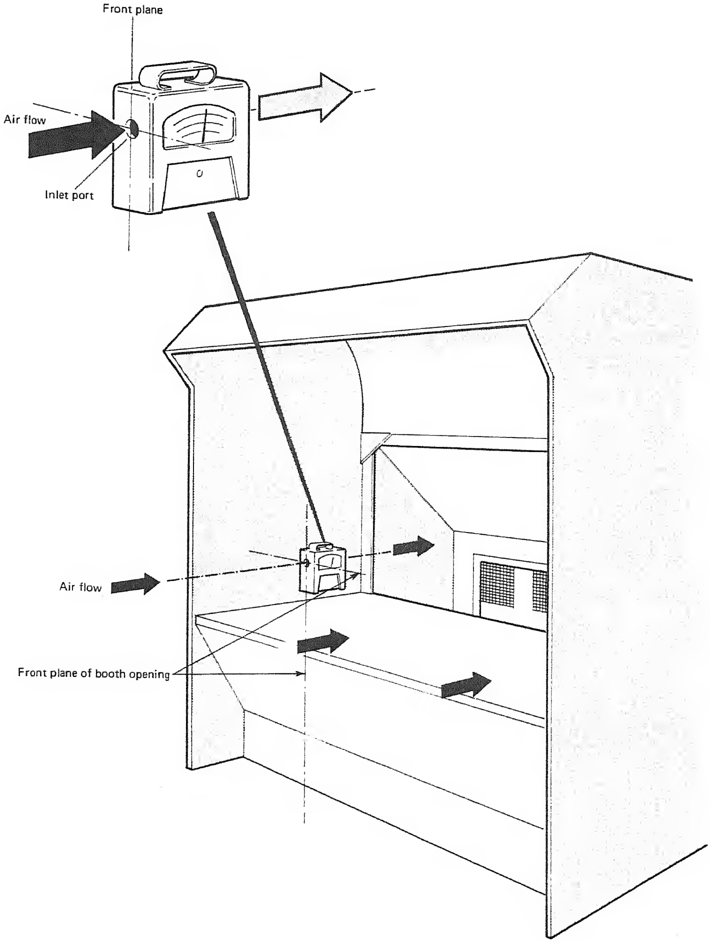


Fig 6 Velometer - Orifice & probe types - Use of orifice velometer - inlet port flush with plane of opening

Rotating Vane Anemometer

78 The basic instrument, which is available in a range of sizes, consists of a number of light vanes supported on radial arms rotating on a common spindle. The spindle is connected to a gear train which transmits the revolutions to a set of counters. The counters record the linear air speed in a measured period. The basic unit is not a direct reading instrument and a simple calculation (dividing the reading by the number of elapsed minutes or seconds) is required to obtain the air velocity. Direct readings can be obtained with newer electronic models.

79 These instruments can only be used to measure air velocities in spaces which are large relative to the instrument size. They cannot be used to measure air velocities in ducts. Air velocities in the range 0.12 to 25 m/s can be measured.

Hot Wire and Heated Thermistor Anemometers

80 The rate of heat loss from a heated body is related to the flow of air passing over that body. The hot wire anemometer uses this relationship and the dependence of electrical resistance on temperature to produce an air velocity reading on a meter.

81 The heated thermistor unit contains a thermistor bead which forms an arm of a Wheatstone bridge circuit. The bead is kept a constant temperature by varying the supply of power to the circui to correct for the cooling effect of the air passing over the bead. The power supplied is displayed in m/s on a meter scale. A second, sealed, thermistor bead is located in the probe but not exposed to the airflow. This second bead compensates the meter for changes in ambient temperature.

82 These devices can be used in much the same way as a swinging vane anemometer and may be used to measure velocities in the range 0-30 m/s.

83 During use, the probe should always be held at arm's length to avoid obstructing the airflow and thereby giving a false reading. When readings are being made at hoods or other openings, the probe should be held in the same plane as the entrance plane of the opening. The hole in the end of the probe should normally be held parallel to the airstream. However, it may be necessary, particularly near the edges of an opening, to gently rotate the probe until the maximum reading is obtained.

Note. This instrument, unlike the Velometer, is non-directional. A light thread tied to the end of the probe, or the use of smoke tubes, should give a clear indication of direction.

AIR PRESSURE MEASUREMENT

84 Static pressure (Ps) is normally measured at various points during the assessment of an LEV system eg behind hoods, in ductwork and across fans and filters.

85 The measurement of static pressure is straightforward and requires the use of a manometer or a Velometer fitted with a static pressure jet (Fig 7).

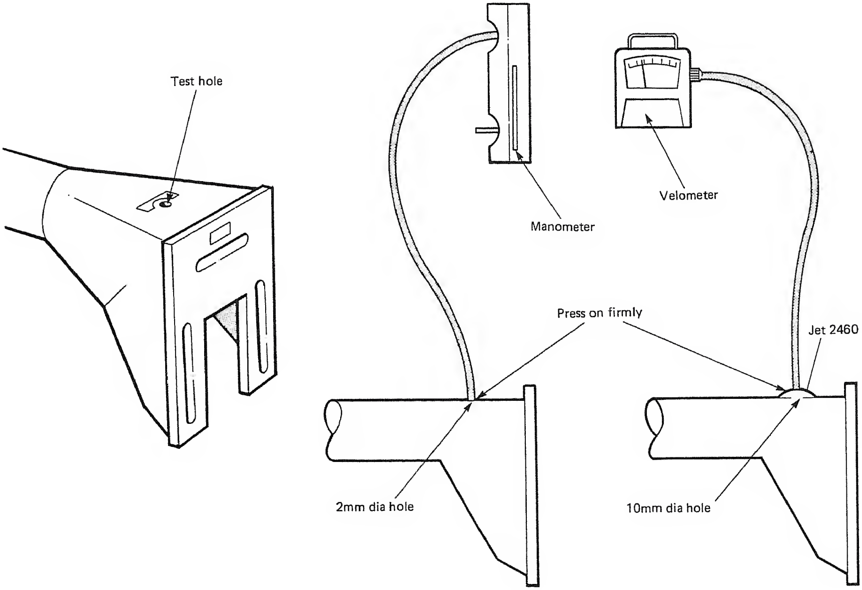


Fig 7 Static pressure readings at Dusgard Hood

86 Static pressure is measured via a hole (drilled rather than punched) in the ducting. The positioning of this hole is not critical but measurements at bends, junctions and other sources of turbulence should be avoided. When using the Velometer, the size of the measuring hole is important and to provide an accurate reading the hole should be not less than 10 mm in diameter; manometers generally require a hole of 2 to 4 mm diameter.

Manometers

87 The vertical 'U' tube is the simplest pressure gauge. However, if small static pressures are to be measured the use of an 'inclined' manometer with its increased sensitivity and scale magnification may be necessary. Both types of manometer must be carefully levelled before readings are taken.

Velometer

88 The Velometer (see paragraphs 73-77) can be used to measure static pressures either above or below atmospheric pressures by connecting the static pressure jet to the inlet or outlet ports on the meter via a length of rubber tubing.

OTHER EQUIPMENT

Smoke Tubes

89 The movement of air into hoods and other inlets can be detecte by injecting smoke into the moving airstream and observing the effects.

90 Smoke tubes produce a chemically generated stream of fine smoke particles. A typical tube consists of a rubber 'puffer' bulb and a glass tube which contains the smoke generating chemical. When the tips of the glass tube have been broken off and the tube inserted in the bulb, the smoke should be ejected slowly and gradually by squeezing the bulb.

Note. The contents of the tubes are hygroscopic and the resultant liquid is corrosive.

91 Although the smoke particles are non-toxic, the tubes should not be used in the food and drink or pharmaceutical industries, or in areas where clean-air conditions are maintained.

Thermometers

92 The air temperature in the majority of LEV systems will be about 20°C and it should not be necessary to make allowances for air temperatures less than 80°C, unless very accurate velocity readings are required.

93 Where the air in the LEV system is likely to be in excess of 80°C eg in metallurgical works, mercury-in-glass or electronic thermometers can be used.

Tachometer

94 A tachometer may be required to check the fan impellor or motor speeds against the design values.

Measuring Tape

95 A flexible steel measuring tape will be required to measure the dimensions of ducts etc on site.

RECORDS

96 The purpose of the Part I and Part II examinations is to ensure that the LEV system provided effectively controls the contaminants. The examinations also provide an indication of the standard of maintenance and monitor the changes in efficiency of the LEV system over time.

97 Records should be kept of the Part I and Part II examinations and tests carried out on LEV. Where a statutory requirement exists concerning the maintenance of such records, the register, Apppendix 2, has been approved for that purpose. This register is also recommended for the maintenance of records in all other situations.

98 Where there is no statutory requirement to maintain records in an approved register, the records should nonetheless contain at least the following information:

(a) the results of the Part I and Part II examinations and tests;

(b) any maintenance which has been carried out;

(c) what defects if any have been detected and what remedial action has been taken; and

(d) any modifications which have been made to the system.

99 The information should be readily retrievable and in an easily understood form. The records should be kept at the place of work, or where this is not reasonable, at a designated office. The records should be available to employees or their representatives at the workplace, in accordance with the requirements of the Safety Representatives and Safety Committees Regulations 1977.

100 A record of any Part II examination and test should be kept for 2 years from the date on which it was carried out. A suitable summary of any air monitoring carried out, where the contaminant is a substance hazardous to health, must be kept for 30 years from the date on which it was made.

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APPENDIX 1: LEGISLATION DEALING WITH DUST AND FUME CONTROL AND LOCAL EXHAUST VENTILATION IN INDUSTRY

LEGISLATION	SECTION OR REGULATION	REQUIREMENT FOR REGULAR INSPECTION/EXAMINATION/TEST		
		SPECIFIC REQUIREMENT	REGISTERY FORM REQUIRED	DETAILS/FREQUENCY
Factories Act 1961	S4 30 63	No		
Asbestos Regulations 1969	R7	Yes	F 2395	Inspection weekly. Thorough examination and test every 14 months by competent person. Please see Discussion Document Pt 1 para 11.
Blasting (Casting and Other Articles) Special Regs 1949	R6-11 R13	Yes	F 637	Inspection weekly. Thorough examination and test every month by competent person.
Bronzing Regulations 1912	R1	No	No	
Chemical Works Regs 1922	R2 3 21 22	No	No	
Chromium Plating Regs 1931	R1	Yes	Yes	Test by appointed responsible person every 14 days.
Coal Mines (Respirable Dust) Regulations 1975	Part IV	No	No	Examination and test required. (frequency not specified).
Construction (General Provisions) Regulations 1961	R20 21	No	No	Testing of atmosphere required. (No frequency quoted).
Flax and Tow Spinning & Weaving Regulations 1906	R2	No	No	
Grinding of Cutlery & Edge Tool Regs 1923	R1 4	Yes	F 90	Examination and test every six months by competent person.
Grinding of Metals (Miscellaneous Industries) Regulations 1925/50	R1 12 17	Yes	F 89	Examination and test every six months by competent person.
Highly Flammable Liquids Regulations 1931	R10	No	No	
Horsehair Regulations 1907	R3 5 6 8	No	No	
India Rubber Regulations 1922	R5	No	No	
Ionising Radiations (Unsealed Radioactive Substances) Regs 1968	R36	No	No	

LEGISLATION	SECTION OR REGULATION	REQUIREMENT FOR REGULAR INSPECTION/EXAMINATION/TEST		
		SPECIFIC REQUIREMENT	REGISTERY FORM REQUIRED	DETAILS/FREQUENCY
Iron & Steel Foundries Regs 1953	R7	No	No	
Jute (Safety, Health & Welfare) Regulations 1948	R6 7 8 9 10	Yes	No	Examination and clean every month.
Control of Lead at Work Regulation 1980	R6 13 14	No	No	Statutory duty to maintain. Practical guidance in Approved Code of Practice specifies weekly inspection and annual thorough examination and test.
Magnesium (Grinding of Castings and Other Articles) Spec Regs 1946	R6 7 8 10 11	No	No	
Mines and Quarries Act 1954	S74 112	No	No	
Non-Ferrous Metals (Melting & Founding) Regs 1962	R11 12	Yes	F 2093	Thorough examination and test every six months by competent person.
Patent Fuel Manufacture (Health & Welfare) Special Regs 1946	R4 5 6 7 8 10 11 12	No	No	
Pottery (Health & Welfare) Special Regulations 1950	R17	Yes	F 658	Thorough examination and test every 14 months by competent person.
Refractory Materials Regs 1931	R2 3 4	No	No	
Shipbuilding and Ship-Repairing Regulations 1960	R53	No	No	
Tinning of Holloware etc Regs 1909	R1 3	No	No	
Vitreous Enamelling Regs 1908	R3	No	No	
Woodworking Machines Regs 1974	R41	No	No	
East India Wool Regulations 1908	R2	No	No	
Wool, Goat Hair & Camel Hair Regulations 1905	R2 4 5 11	No	No	

APPENDIX 2: REGISTER OF THOROUGH EXAMINATION AND TEST OF LOCAL EXHAUST VENTILATION PLANT FOR THE PURPOSE OF INTERCEPTING AIRBORNE CONTAMINANTS

Name of Occupier of Factory: ____________________

Address of Factory: ____________________

Type of Industry: ____________________

PART I – Results and data obtained at initial or Supplementary examination and test.

PART II A & B – Periodic examination and test.

PART III – Schedule of cleaning, maintenance, modification and repair.

PERIOD COVERED BY THIS REGISTER

____________ TO ____________

THIS REGISTER SHOULD BE USED TO RECORD PARTICULARS OF EXAMINATIONS AND TESTS CARRIED OUT UNDER THE FOLLOWING REGULATIONS:

The Blasting (Casting and Other Articles) Special Regulations 1949 - Regulation 11(1) & (2).

Non-Ferrous Metals (Melting and Founding) Regulations 1962 - Regulation 12.

Grinding of Metals (Miscellaneous Industries) Special Regulations 1925 & 1950 - Regulation 17.

The Pottery (Health and Welfare) Special Regulations 1950 - Regulation 17(8).

Grinding of Cutlery and Edge Tools Special Regulations 1925 & 1950 - Regulation 4.

Control of Lead at Work Regulations 1980.

40

NOTES

1 ALL MEASUREMENTS SHOULD BE EXPRESSED IN METRIC UNITS.

2 ASSESSMENT OF LEVEL OF CONTROL (SEE PAGES 4 AND 7).

(1) The assessment is to determine:

(a) whether the contaminant produced is effectively and simultaneously extracted at each extraction point in the system;

(b) whether the contaminant extracted is effectively conveyed by the exhaust draught to the filter/collector;

(c) whether there is any leakage or discharge of dust into the air of any workplace from any part of the exhaust ventilation equipment;

(d) whether the filter/collector is in good order.

(2) State whether the level of control is satisfactory or unsatisfactory, and the method by which the assessment was made.

(3) For the purposes of the Part I examination and test:

(a) if the control is assessed as SATISFACTORY, insert the word "satisfactory" in the box provided and complete the rest of the particulars in Part I of the register;

(b) if the control is assessed as UNSATISFACTORY, do NOT enter any particulars in Part I but, instead, complete Part II of the register, indicating the defects and the repairs that are required and noting that a Part I examination was attempted but unable to be completed. (Do not enter anything in Part I).

3 A PART I CERTIFICATE SHOULD BE GIVEN:

(a) as soon after the commissioning of the plant as possible, or in conjunction with the commissioning;

(b) in the case of existing plant, if no earlier Part I examination has been carried out;

(c) if any subsequent alterations are made to the plant.

4 ANSWER ALL QUESTIONS.

PART I

RESULTS AND DATA OBTAINED AT INITIAL/SUPPLEMENTARY THOROUGH EXAMINATION AND TEST

DESCRIPTION OF PLANT OR PROCESS IN CONNECTION WITH WHICH THE VENTILATING PLANT OR DUST COLLECTION APPARATUS IS USED (STATE CONTAMINANT CONCERNED)

Regulation

Max. Period Between Thorough Examinations

ASSESSMENT OF LEVEL OF CONTROL ☐

Note - See Page 3

Test carried out: Air Sampling/Dust Lamp*
(*Delete as necessary)

CONDITIONS AT TIME OF TEST
eg normal production/maximum use

COMMENTS

IS THE EXHAUST AIR RETURNED TO THE WORKPLACE? YES/NO
If YES what is the concentration of contaminant in the return air?

(NB. If secondary filter equipment is also provided, complete secondary filter information opposite).

NAME OF PERSON RESPONSIBLE FOR TEST

SIGNATURE

DESIGNATION

DATE

EMPLOYER

DISTINGUISHING NAME, NUMBER OR DESIGNATION OF PLANT

AIR MOVER/FAN	
Make	
Model	
Fan Total Volume Flow	
Static Pressure at Fan Inlet	
Motor Rating HP/KW	
Motor Current Amps	
Motor/Fan Speed	
Fan Size	
Direction of Fan Rotation Looking at Drive End	
System Air Temperature at Time of Examination	

FILTER/COLLECTOR	
Make	
Model	
Volume Flow	
Static Pressure Reading	
Filter Inlet	
Filter Outlet	
Across Filter	
Filter Medium	

Is secondary filter equipment provided
If YES complete the following: YES/NO

Type

Area Media

Static pressure at inlet
Static pressure at outlet

Particulars of any automatic monitoring device

SCHEMATIC ARRANGEMENT

ENCLOSURES/HOODS			DUCTING			
Specific Point of Extraction	Static Pressure Reading Immediately Behind Hood Ps	Face Velocities and Positions (attach further sheet if necessary)	Section	Diameter	Average Duct Velocity	Volume Flow

No. of Extraction Points	Max. No. Designed to be Used at Any One Time
Reference of Arrangement/Layout Drawings which Identify the Plant	

PART II

IIA - REPORT OF PERIODIC THOROUGH EXAMINATION AND TEST

Regulation

Max. Period Between
Thorough Examinations

(NB. If filtered air is returned to the workplace, complete Part IIB also)

DISTINGUISHING NAME, SERIAL NUMBER OR DESIGNATION OF PLANT								ARE THE PART I THOROUGH EXAMINATION AND TEST DATA AVAILABLE? YES/NO (If not, a Part I examination should be carried out)				
DATE OF EXAM.	DESIGNATION AND SIGNATURE OF PERSON MAKING THE TEST	DO THE CONTROLLED SUBSTANCE, PROCESS AND PLANT ELEMENTS COMPLY WITH PART I DETAILS. IF NOT, LIST ALTERATIONS.	ASSESSMENT OF LEVEL OF CONTROL.* Also state tests carried out: (a) Visual; (b) Dust lamp; (c) Air sampling: (d) Other	STATIC PRESSURE IMMEDIATELY BEHIND EACH EXTRACTION POINT: (Insert references for points)						STATIC PRESSURE ACROSS FILTER/ COLLECTOR		
										At Inlet	At Outlet	Diff-eren-ces

DATE OF EXAM.	WHERE APPLICABLE, ARE ELEMENTS IN GOOD WORKING CONDITION? Answer YES, NO or N/A					PARTICULARS OF REPAIRS OR MODIFICATIONS REQUIRED TO ENSURE THAT THE VENTILATION PLANT EFFECTIVELY INTERCEPTS, REMOVES AND DISPOSES OF DUST OR FUME	DATE REPAIRS COMPLETED (See Part III)
	Encl.	Hoods	Ducts	Air Mover	Filt/ Coll		

PART II CONTINUED

REGULATION
MAX PERIOD BETWEEN THOROUGH EXAMINATIONS

IIB - PARTICULARS OF EXHAUST VENTILATION EQUIPMENT RETURNS FILTERED AIR TO THE AIR OF ANY WORKPLACE

DATE OF EXAM.	QUANTITY OF CONTAMINANT IN THE RETURNED AIR*	NAME(S) AND QUALIFICATION(S) OF PERSON(S) MAKING THE TEST IN COL (2)	PARTICULARS OF ANY AUTO MONITORING DEVICE FITTED AND WHEN TESTED; WHETHER IT WAS IN GOOD CONDITION	PARTICULARS AS TO THE CONDITION OF THE FILTER

PART III

SCHEDULE OF CLEANING, MAINTENANCE, MODIFICATION AND REPAIR

REGULATION

DISTINGUISHING NAME,
NUMBER OR DESIGNATION
OF PLANT

DETAILS OF MODIFICATIONS OR REPAIR WORK CARRIED OUT	REPAIRS COMPLETED		PARTICULARS OF PERSON RESPONSIBLE FOR REPAIRS NAME, DESIGNATION, EMPLOYER
	DATE	INITIAL	

DATE OF CLEANING	DESIGNATION OF WORKPLACE WHICH HAS BEEN CLEANED	TREATMENT (EG VACUUM CLEANED, WASHED)	NAME AND ADDRESS OF PERSON PERFORMING THE CLEANING, OR WHEN MORE THAN ONE IS EMPLOYED, OF THE PERSON IN CHARGE

APPENDIX 3: THOROUGH EXAMINATION AND TEST OF LOCAL EXHAUST VENTILATION PLANT FOR THE PURPOSE OF INTERCEPTING AIRBORNE CONTAMINANTS

NOTES ON THE COMPLETION OF THE REGISTER

ADVICE TO COMPETENT PERSONS

THOROUGH EXAMINATION AND TEST OF LOCAL EXHAUST VENTILATION PLANT:

ADVICE TO COMPETENT PERSONS

GENERAL CAUTION:

The plant should be capable of being examined without risk to the safety of the competent person. Adequate means of access should be provided to all parts at which readings are required to be taken. If safe means of access are not available, the examination should not be attempted and a certificate of thorough examination and test should be refused. It is the factory occupier's duty to be in possession of a current certificate and if he wishes to comply with the Regulations he must provide the means for the plant to be properly examined.

It should also be ensured that adequate personal protection is used by all persons carrying out inspection and test work on local exhaust ventilation plant. This will include protective clothing and suitable respiratory protective equipment where necessary.

* * * * * * * * * * * * * * * *

THE TWO-PART EXAMINATION SYSTEM AND NEW REGISTER

The new Register incorporates into one document and in a common form all the particulars which are required to be recorded under the seven different Regulations listed on its page 2. These are all the Regulations which at present specifically require the examination and test of ventilating plant by a competent person at set intervals, as a check that the ventilation equipment is actually doing the job it is supposed to be doing - that is, effectively preventing the escape of the various harmful dusts and fumes into the air which workpeople are breathing.

Under the new system, an in-depth test will always be carried out at each inspection but the main departure from the previous system lies in the requirement, now, to record in detail the condition and performance of the plant when it is extracting the dust or fume at a satisfactory level of efficiency. The recording of these data provides a yardstick against which the results of subsequent tests can be compared. This is what is meant by the new two-part examination system. The particularly detailed examination should therefore take place as a one-off exercise, at the outset, as soon as new plant is commissioned, or else, in the case of existing plant, at the first inspection. The exercise will only need to be repeated if the plant is modified or altered at a later date.

The detailed, engineering data are the particulars required by Part I of the new Register. Part II of the Register records the subsequent, periodic, examinations and tests. It is divided into two sections, A and B, the additional information in Section B applying only if the ventilation equipment returns filtered air to the workroom. Part III is a record of cleaning, maintenance, modification or repair of the plant. Together, these three parts form a comprehensive and essential accumulation of information about each item of plant.

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COMPLETION OF THE REGISTER

A FIRST EXAMINATION : PART I

At the first inspection, the examination and test should provide the information required by Part I.

1 The particulars required to be completed on the front cover (page 1) of the Register are self-explanatory. Page 2 of the Register merely lists the Regulations in connection with which the Register should be used. The notes on page 3 of the Register should be read carefully before commencing the examination.

The instruments and methods which may be used for the examination are detailed in the next section of these Guidance Notes.

2 The particulars required by Part I commence on page 4 of the Register. After completing a brief description of the plant (eg "fettling bench: silica dust"), noting its name or number, inserting the relevant Regulation and the maximum period between examinations, as specified in the relevant Regulation (eg "6 months"), the main object of attention should then be the assessment of level of control. The level of control of the contaminants should be assessed by use of either the dust lamp or air sampling techniques, or both. The need for both methods to be used will depend on the individual circumstances. (In any case, if the exhaust air is returned to the workplace, air sampling will automatically need to be carried out to determine the concentration of the contaminant in the returned air; the possible contamination of the returned air is one factor which needs to be taken into account in assessing the overall level of control). Results of air sampling should be compared with the current control limits, as published in HSE Guidance Notes. The aspects which need to be considered in the assessment are.

(a) whether the contaminant produced is effectively and simultaneously extracted at each extraction point in the system;

(b) whether the contaminants extracted is effectively conveyed by the exhaust draught to the filter/collector;

(c) whether there is any leakage or discharge of dust into the air of any workplace from any part of the exhaust ventilating equipment, and

(d) whether the filter/collector is in good order.

IMPORTANT: The level of control should be judged as either satisfactory or unsatisfactory. If it is assessed as satisfactory, the word "SATISFACTORY" should be inserted in the box provided, as a positive statement, and the remaining particulars in Part I of the Register completed. If the level of control is not satisfactory, nothing further should be entered in Part I; instead, an entry should be made in Part II, detailing the repairs that are necessary in order to bring the plant upto an acceptable level of performance. (A note should also be made in Part II that a Part I examination was attempted but could not be completed).

3 Continuing with the left hand side of page 4 of the Register, the conditions applying at the time of the test should be noted. Usually, this will be "normal levels of production", but if, owing to abnormal circumstances such as a breakdown, only part of the system is working, this should be recorded.

A space has been made available for comments. This should be used for any notes or points which the competent person wishes to bring to the attention of the occupier or succeeding competent persons - eg concerning identification of plant, or instructions for future repairs which do not currently affect the efficiency of the plant.

An essential point is whether the exhaust air is returned to the (or any) workplace. A specific answer, "yes" or "no" should be given. If the air is returned, the concentration of the contaminant in it should be determined by air sampling, and should be expressed in such units as milligrammes per cubic metre (mg/m^3) or fibres per millilitre (fibres/ml). Obtaining these measurements will require the services of a skilled occupational hygienist, unless the engineer surveyor has received special training in this field. If secondary filter equipment is also present, the relevant additional questions on the right hand side of the page must be answered, too.

Some systems returning filtered air to the workroom are not fitted with a secondary filter, reliance being placed on the efficiency of the main or primary filter and on any monitoring device fitted to ensure that the amount of the contaminant in the returned air is kept to a suitable level. The advice of HSE should be sought if there is any query over the return of filtered air to the workroom in any particular case.

4 The right hand side of page 4 of the Register lists the engineering data for the air mover or fan and for the filter and collector. (The term air mover/fan is used because it could be the case that the system air mover is a turbo-exhauster unit or possibly a venturi device).

AIR MOVER/FAN:

(a) The make and model should be entered (eg Keith Blackman; Senior 24: 30-M).

(b) Fan total volume flow - This is the actual air flow passing through the fan, calculated from the average velocity and duct area of the ductwork either entering or leaving the fan.

It is sufficient to record either the air flow through the filter/collector or the air flow through the fan.

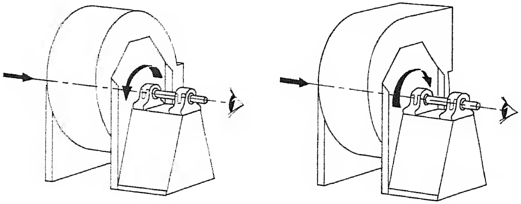
(c) Static pressure at fan inlet is measured in the ductwork connected to the fan inlet, as near as possible to the inlet.

(d) Motor rating HP/KW)
(e) Motor current Amps) These are self explanatory and refer to the motor driving the fan

(f) Motor/fan speed - The fan speed, obtained by tachometer or similar instrument, is the more useful reading since air flow and system resistance are based on this and will be affected by changes.

(g) Fan size - May not be required if fan type/model have already been given. Otherwise when such information is not available, the fan size in terms of one or more physical dimensions should be stated.

(h) Direction of fan rotation looking at drive end - The direction of rotation of a centrifugal fan is defined as being clockwise or counter-clockwise when viewed from the drive side (the drive side of the fan is between the observer and the casing of the fan).



(Taken from Eurovent 1/1)

Counter-Clockwise Rotation

Clockwise Rotation

Direction of rotation of centrifugal fans

(i) System air temperature - In the great majority of cases the air temperature (ie the temperature of the air carrying the contaminant) will be the same as shop air temperature. Occasionally (as from a metallurgical plant) the system air temperature will be higher, and may need to be recorded at various points (ie at entrance to filter/collector or in ductwork). System air temperatures below about 80°C need not be recorded.

FILTER/COLLECTOR:

(a) Make and Model should be stated (eg DCE; Wet: Series MG).

(b) Volume flow - This is preferably the actual air flow entering the filter/collector, as calculated from the average velocity and the duct area of the inlet ducting. The average velocity is determined by methods discussed in the next section. The air flow could also be calculated from measurements at the outlet ducting but in this case the air flow would include any in-leakage to the filter/collector. (These remarks apply to the case where the fan is down-stream from the filter/collector).

(c) Static pressure reading: Filter inlet - This is the static pressure (Psi) measured by manometer at a point in the inlet duct to the filter itself. In the case of bag filters this might also be the pressure measured in the chamber, on the dirty side of the filter.

Example: Psi = -70 mm WG

(d) Filter outlet - This is the static pressure (Pso) measured by manometer at a point in the outlet duct from the filter. In the case of bag filters this might also be the pressure measured at a point on the filter unit on the clean side of the filter.

Example: Pso = -170 mm WG

(e) Across Filter - This is the differential pressure drop across the filter/collector unit ($\triangle p$).

Example: From the above readings:

$$\begin{aligned} \triangle p &= Psi - Pso \\ &= -70 - (-170) \\ &= 100 \text{ mm WG} \end{aligned}$$

(f) Filter medium - This is obtained from the specification and applies where a fabric filter is used.

Examples: Cotton; Wool; Terylene; Orlon; Teflon; Glass.

(g) Secondary filter equipment - It should be specifically stated whether this is, or is not, present. If it is, the following additional information should be given:

(h) Type - Example: Vokes panel filter.

(i) Area - Cross sectional area of the filtering medium through which the air passes.

(j) Media - These are the filtering materials through which the air passes.

Examples: Glass filament; Synthetic fibre.

(k) Static pressure at inlet)
Static pressure at outlet)

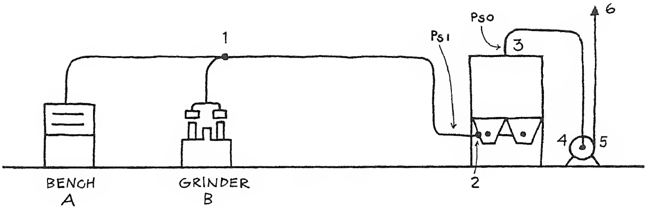
These pressures will be negative or positive depending on the relative position of fan and filter. They will be measured with a manometer or equivalent. If the filter is upstream from the fan, the pressures will be negative; if downstream from the fan they will be positive. For example:

Filter upstream	Inlet pressure = - 180 mm WG	Outlet pressure = - 190 mm WG
Filter downstream	Inlet pressure = 13 mm WG	Outlet pressure = 3 mm WG

(l) Particular of any automatic monitoring device - The secondary filter may for example be fitted with a manometer which detects pressure drop across the filter and which actuates a warning or control device if such pressure drop exceeds a set figure. The warning or control device may be a lamp, buzzer or motorised by-pass damper or some other device.

5 Turning to page 5 of the Register, the next information required is a schematic drawing of the plant, showing the arrangement. If there is no layout drawing available, an annotated line sketch is made here.

Example:



The next two entries:

No. of extraction points and Max. No. designed to be used at any one time

indicate, respectively, the total number of extraction points on the system and the number designed to be in use at any one time. In the example above "2" would be inserted in both boxes.

If an arrangement and/or a layout drawing of the system is available then the reference information (drawing number, date and initials) can be entered, in which case a schematic arrangement may not be required.

On the right of the page, information on the hoods or enclosures and the ducting is intended to cross-reference with the information on the sketch.

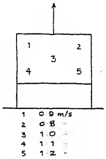
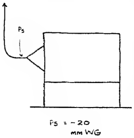
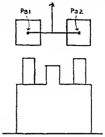
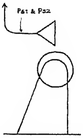
Enclosure/Hoods:

Specific points of extraction - each extraction point such as an enclosure or a hood is given a distinguishing mark, number or other description and is listed separately.

For each extraction point the static pressure reading immediately behind hood is given and also, where applicable, face velocities and positions.

The static pressure is taken at some point in the ductwork which is connected to the inlet and as close to the inlet as practicable. It is shown in the Register as a negative pressure (ie -15 mm WG or other appropriate unit). Face velocities are taken at the face of the enclosure at selected points and the position of these is shown.

A thumb-nail sketch of each inlet enables these readings to be shown, as in the following examples:

ENCLOSURES/HOODS		
SPECIFIC POINT OF EXTRACTION	STATIC PRESSURE READING IMMEDIATELY BEHIND HOOD Ps	FACE VELOCITIES AND POSITION (attach further sheets if necessary)
BENCH A	 1 0.9 m/s 2 0.8 " 3 1.0 " 4 1.1 " 5 1.2 "	 Ps = -20 mm WG
GRINDER B	 Ps1 = -120 mm WG ; Ps2 = -125 mm WG	

Separate sheets may be required if there is insufficient space on page 5 for all the extraction points to be shown.

The static pressure at each inlet should be noted at the Part I examination. On large and complex systems static pressure in the ductwork serving a small group of inlets may be noted for comparison in subsequent Part II examinations but this should be backed up by the use of a dust lamp where particulates are concerned.

Ducting

The following information should be given on the ducting:

(a) Section - This is a distinguishing mark of the section of ductwork being considered (ie B-1; 1-2 as shown in this Guide).

(b) Diameter of the duct (or in the case of ducting other than round, those dimensions which will enable the duct area to be calculated).

(c) Average duct velocity)
(d) Volume flow)

The average duct velocity is found from a pitot, or similar, traverse across the duct as explained in the guidance.

Example:

DUCTING			
SECTION	DIAMETER	AVERAGE DUCT VELOCITY	VOLUME FLOW
1-2	350 mm	15 m/s	1.44 m^3/s

In the example shown, diameter of the duct 1-2 on the schematic arrangement (page 6) = 350 mm.
Duct area = 0.0962 m^2 = (A).
Average duct velocity = 15 m/s = (V).
So volume flow (Q) = V.A.
= 15 x 0.0962
= 1.44 m^3/s.

6 Finally, turning back to page 4 of the Register, the competent person should sign and date the Part I certificate, and complete the remaining details required.

B) SUBSEQUENT EXAMINATIONS: PART II

At each subsequent inspection, the examination and test should provide the information required by Part IIA (pages 6 and 7 of Register) and, where applicable, Part IIB (page 8); (Part IIB is devoted to particulars about returned air).

The introductory information on page 6 of the Register is the same as for Part I. The question then is asked "are the Part I thorough examination and test data available?". Only if the answer to this is "yes" should a Part II examination be carried out in full.

Following the entry of the date and the competent person's signature, the next question, asking whether, as far as can be ascertained, the controlled substances, processes and [plant] elements comply with [the specifications at] Part I, is an important one. A "yes" or "no" answer should be given. If there are now differences, the decision has to be taken as to whether the differences are sufficiently important as to warrant a new Part I examination, or whether they are minor enough to permit just a supplementary note to be attached to the existing Part I certificate.

The assessment of level of control is, as before, the crucial question, and the same considerations apply. If the condition and performance of the plant have obviously not deteriorated at all since the Part I, or previous examination, then, in the case of less toxic dust or fumes, air sampling or the dust lamp will not necessarily have to be used each time.

The type and extent of the tests carried out will obviously depend on the professional judgement of the competent person, and some discretion may need to be exercised. For instance, on large and complex systems it may not be practicable to take static pressure readings at each extraction point. In this case a static pressure reading taken in the ductwork serving a small group of extraction points may be acceptable provided that the level of control is also checked using the dust lamp.

In the case of the static pressure immediately behind each extraction point, the position of each point should be identifiable from the Part I information. It should be checked in the same way and compared with Part I information.

Example:

Static pressure immediately behind each extraction point			
A	B 1	B 2	
-10 mm WG	-60 mm WG	-65 mm WG	

There are six columns in the Register; if the system has more extraction points than this, a separate sheet will be needed.

The static pressures must then be compared with those shown in Part I. Judgement needs to be made as to whether the latest results are entirely satisfactory or whether further evidence, such as by the use of dust lamp, is required.

The static pressure across the filter/collector should be determined, as in Part I.

The particulars of the examination are continued on page 7 of the Register; for the sake of easy reference the date should be repeated.

The condition of the elements of the system should next be considered, and a separate answer for each given to the question "are elements in good working condition?"

This is essentially a visual examination procedure. The condition of all extraction points must be examined as to state of repair, position relative to source of contamination, and integrity of fixings and brackets. The condition of ducting includes its state of repair, and internal cleanliness.

The filter/collector and fan require internal examination and a comment on the state of repair of mechanical, electrical and structural parts of these elements should be given.

Note - A "no" comment requires an explanation.

Particulars of repairs or modifications required to ensure that the ventilation plant effectively intercepts, removes and disposes of dust or fume - This is a report in narrative form indicating the action necessary, and is similar to the system used with previous registers. The comments in this section should give an indication of the degree of urgency or significance of the repairs required.

Date repairs completed (see Part III) - This entry is made by the occupier to cross-refer the report of work necessary, to repairs that he has done.

The Register continues on page 8 with information about the returned air system where present. It refers to the return air system described in Part I of the Register.

Quantity of contaminant in the returned air - Unless there is a specific requirement for this information it would not normally be necessary to carry out air sampling on each occasion, if other test data compare well with Part I results. It should be determined by actual measurement, independent of any device which may be part of a monitoring device, at the time of the test and examination when the equipment is simultaneously extracting dust from each place served.

Name and qualification(s) of person(s) making test in column 2 - If air sampling is carried out particulars of persons making the test are required. A separate report of the test, signed by the person making it, must be attached to the Register; no actual signature is needed in this box.

Other particulars required on page 8 are self explanatory. Particulars as to the condition of the filter refers to the secondary filter when fitted.

C) SCHEDULE OF CLEANING, MAINTENANCE, MODIFICATION AND REPAIR: PART III

This section is intended to be completed by the occupier. The competent person will obviously need to refer to the entries contained in it before undertaking each periodic examination, since his decision as to the scale, scope and depth of the examination, (or whether a new Part I is needed), will depend to a large extent on the particulars entered here. If the occupier has omitted to enter any information, it should be assumed, in the first instance, that no cleaning or maintenance or repairs have been carried out, and the competent person's examination should consequently be correspondingly more rigorous.

* * * * * * * * * * * * * * * *

TABLE OF CONVERSION FACTORS
(Using Calculator)

MULTIPLY	BY	TO OBTAIN
m/s	196.85	ft/min
ft/min	0.00508	m/s
m	3.2808	ft
ft	0.3048	m
ins WG	249	N/m^2(Pascal)
N/m^2	0.004	ins WG
m.bar	0.407	ins WG
ins WG	2.457	m.bar
m^3	35.31	ft^3
ft^3	0.0283	m^3
lb.f	4.45	N
N	0.225	lb.f
m^3/hr	0.588	ft^3/min
ft^3/min	1.7	m^3/hr
m^3/s	2118.6	ft^3/min
ft^3/min	0.0005	m^3/s

m - metre
ft - feet
ins - inch
N - Newton
hr - hour

min - minute
s - second
WG - water gauge
m.bar - millibar
lb.f - pound force

Area	Address	Tel. No.	Local Authorities within each Area
01 SOUTH WEST	Inter City House, Mitchell Lane, Victoria Street, Bristol BS1 6AN	0272 290681	Avon, Cornwall, Devon, Gloucestershire, Somerset, Isles of Scilly
02 SOUTH	Priestley House, Priestley Road, Basingstoke RG24 9NW	0256 3181	Berkshire, Dorset, Hampshire, Isle of Wight, Wiltshire
03 SOUTH EAST	3 East Grinstead House, London Road, East Grinstead, West Sussex RH19 1RR	0342 26922	Kent, Surrey, East Sussex, West Sussex
04 LONDON NW	Chancel House, Neasden Lane, London NW10 2UD	01-459 8845	Barnet, Brent, Camden, City of London, Enfield, Ealing Hammersmith, Harrow, Hillingdon, Hounslow, Kensington & Chelsea, City of Westminster
05 LONDON NE	Maritime House, 1 Linton Road, Barking, Essex 1G11 8HF	01-594 5522	Barking, Hackney, Haringey, Havering, Islington, Newham, Redbridge, Tower Hamlets, Waltham Forest
06 LONDON S	1 Long Lane, London SE1 4PG	01-407 8911	Bexley, Bromley, Croydon, Greenwich, Kingston, Lambeth, Lewisham, Merton, Richmond, Southwark, Sutton, Wandsworth
07 EAST ANGLIA	39 Baddow Road, Chelmsford, Essex CM2 0HL	0245 84661	Essex except the London Borough in Essex covered by Area 05: Norfolk, Suffolk
08 NORTHERN HOME COUNTIES	14 Cardiff Road, Luton, Beds LU1 1PP	0582 34121	Bedfordshire, Buckinghamshire, Cambridgeshire, Hertfordshire
09 EAST MIDLANDS	Belgrave House, 1 Greyfriars, Northampton NM1 2BS	0604 21233	Leicestershire, Northamptonshire, Oxfordshire, Warwickshire
10 WEST MIDLANDS	McLaren Building, 2 Masshouse Circus, Queensway, Birmingham B4 7NP	021-236 5080	West Midlands
11 WALES	Brunel House, 2 Fitzalan Road, Cardiff CF2 1SH	0222 497777	Clwyd, Dyfed, Gwent, Gwynedd, Mid Glamorgan, Powys, South Glamorgan, West Glamorgan

12	MARCHES	The Marches House, Midway, Newcastle-under-Lyme, Staffs ST5 1DT	0782 610181	Hereford & Worcester, Salop, Staffordshire
13	NORTH MIDLANDS	Birkbeck House, Trinity Square, Nottingham NG1 4AU	0602 40712	Derbyshire, Lincolnshire, Nottingham
14	SOUTH YORKSHIRE	Sovereign House, 40 Silver Street, Sheffield S1 2ES	0742 739081	Humberside, South Yorkshire
15	W & N YORKS	8 St Pauls Street, Leeds LS1 2LE	0532 446191	North Yorkshire, West Yorkshire
16	GREATER MANCHESTER	Quay House, Quay Street, Manchester M3 3JB	061-831 7111	Greater Manchester
17	MERSEYSIDE	The Triad, Stanley Road, Bootle L20 3PG	051-922 7211	Cheshire, Merseyside
18	NORTH WEST	Victoria House, Ormskirk Road, Preston PR1 1HH	0772 59321	Cumbria, Lancashire
19	NORTH EAST	Arden House, Regent Centre, Gosforth, Newcastle upon Tyne NE3 3JN	091-285 0111	Cleveland, Durham, Northumberland, Tyne and Wear
20	SCOTLAND EAST	Belford House, 59 Belford Road, Edinburgh EH4 3UE	031-225 1313	Borders, Central, Fife, Grampian, Highland, Lothian, Tayside, & the island areas of Orkney and Shetland
21	SCOTLAND WEST	314 St Vincent Street, Glasgow G3 8XG	041-204 2646	Dumfries and Galloway, Strathclyde, and the Western Isles

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